Relations of AI, Robotics and Machine Learning

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What is AI?

The science of making machines

- **think like people.** Not AI anymore, mix of cognitive science and computational neuroscience.
- **act like people.** No matter how they think, actions and behavior must be human-like. Dates back to Turing. But should we mimic even human errors?
- **think rationally.** Requires correct thought process. Builds on philosophy and logic: how shall you think in order not to make a mistake? Our limited ability to express the logical deduction.
- **act rationally.** Care only about what they do and if they achieve their goals optimally. Goals are described in terms of the utility of the outcomes. *Maximize the expected utility of the outcomes of their decisions.*

Good decisions:

- Take into account similar situations that happened in the past. **Machine learning.**
- Simulations using a model of the world. Be aware of the consequences of your actions and plan ahead. **Inference, planning.**

Artificial Intelligence

Studies of *intelligence in general*:

- How do we *perceive* the world?
- How do we *understand* the world?
- How do we *reason* about the world?
- How do we *predict* the consequences of our actions?
- How do we act to *influence* the world?

Artificial Intelligence (AI) not only wants to understand the "intelligence", but also wants to

- create an intelligent entity (agent, robot)
- imitating or improving
- the human behavior and effects in the outer world, and/or
- the inner human mind processes and reasoning.

Robot vs. agent:

- very often interchangeable terms describing systems with varying degrees of autonomy able to predict the state of the world and effects of their own actions. Sometimes, however:
- **agent:** the software responsible for the "intelligence"
- **robot:** the hardware, often used as substitute for humans in dangerous situations, in poorly accessible places, or for routine repeating actions

Requirements for an Ideal Agent

Knowledge representation:

- how to store the model of the world, the relations between the entities in the world, the rules that are valid in the world, ...

Automated reasoning:

- how to infer some conclusions from what is known or answer some questions

Planning:

- how to find an action sequence that puts the world in the desired state

Pattern recognition:

- how to decide about the state of the world based on observations

Machine learning:

- how to adapt the model of the world using new observations

Multiagent systems:

- how to coordinate and cooperate in a group of agents to reach the desired goal

Natural language processing:

- how to understand what people say and how to say something to them

Computer vision:

- how to understand the observed scene, what is going on in a sequence of pictures

Robotics:

- how to move, how to manipulate with objects, how to localize and navigate

...

Course outline

1. The relations of AI, ML, and robotics. Pattern recognitions, Bayesian and non-Bayesian tasks. Learning.
2. Linear regression. Logistic regression. Basis expansion. Regularization.
3. Linear discriminant function, perceptron (rehearsal). Optimal separating hyperplane. Support vector machine. Bias-variance trade-off.
4. Decision trees. Adaboost.
5. Feature selection and extraction. Sequential pattern recognition, Wald's algorithm.
6. Computational learning theory. Consistency, capacity. Probably approximately correct learning.
7. Artificial life, principles, algorithms, applications.

8.-13. Planning and multiagent systems.